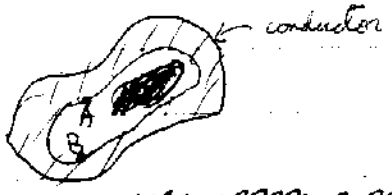
Homework 5 official Solutions

II Jackson 1.1.

a) Any excess charge must be on the surface of a conductor because by Gauss's law electric field over a small volume element is nonzero if there is charge there. However, since charges are free to move inside the conductor, this will not be an equilibrium situation. Also, hence electric field inside the conductor is 0

b)



Consider two points A and B on the conductor.

Since $\oint \vec{E} \cdot d\vec{l} = 0$,

$$\int_{A,\,\text{path 1}}^{B} \vec{E} \cdot d\vec{l}_1 + \int_{B,\,\text{path 2}}^{A} \vec{E} \cdot d\vec{l}_2 = 0$$

Let path 1 be inside the conductor and path 2 be in the hollow region. Because of part a),

$$\int_{A,\,\text{path 1}}^{B} \vec{E} \cdot d\vec{l} = 0 \quad \Rightarrow \quad \int_{B,\,\text{path 2}}^{A} \vec{E} \cdot d\vec{l}_2 = 0 .$$

Hence every point on the inner surface of the conductor is at same potential. By Gauss's law, there is no normal component of electric field on the inner surface of the conductor. (i.e. 

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Any where further inside the hollow shell cannot have any electric field since all pill box contains 0 charge while $\vec{E} = 0$ on the pill box closer to the surface.